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VOL. IV JANUARY, 1953 NO. 47

THE FUEL FRONT

THE unsatisfactory negotiations which are taking place between the National Coal Board and the National Union of Mineworkers is of concern to the whole of British industry, but particularly so in the case of the ceramic industry, where fuel usage is an important item on the cost schedule.

When one looks at the capital investment programme for electricity and gas, and these are in turn correlated with the gloomy forecasts of coal production emanating from the National Coal Board, the lack of integration within the fuel industries becomes very apparent. Quite obviously the major problem is to produce the quantity of coal necessary to keep the new gas-making and electrical generators fed, otherwise they represent a wasted national capital investment.

The National Coal Board, in spite of high prices to the consumer, is still losing between two and three shillings per ton on all the coal it disposes of. Orthodox mechanisation has been introduced without any corresponding effect upon the output per man-shift. Either the National Coal Board is right in its statement that it cannot produce substantially more than its present output or else it is wrong. If it is wrong it is time that the extent of its error was pointed out. If it is right, quite obviously again the distribution of our fuel resources must be reviewed. On the other hand, if it is confirmed that with our present mining construction the coal output is limited to the figures given by the National Coal Board, then the greatest proportion of the nation's capital investment in fuel must surely be directed towards the sinking of new shafts and tackling the business of coal-getting in a satisfactory manner.

In this respect the recent remarks made by the Managing Director of Power Jets Ltd., in which he recommended greater use of oil in industry to conserve our one national asset, namely coal, are well worth consideration.

STRESSES AND STRAINS IN GLAZES

Their Measurement and Importance in the Ceramic Industries

(SPECIALLY CONTRIBUTED)

THE crazing of glazes has always been a fault which recurs from time to time to harass the potter. In earlier times it was regarded somewhat as an unavoidable evil, and since crazing is often regarded as a sign of antiquity in ware, it has been deliberately brought about in modern reproductions by using the so-called "crackle glazes."

Crazing and Peeling Due to Differences in Contraction

In later times the mechanism of crazing has become better understood, and it is less of a problem than it was say fifty years ago. Crazing and peeling arise from strains or stresses set up in the glaze as a result of differences in contractions between body and glaze after the latter has become rigid. This was put forward in 1876 by W. Schumacher[1] to explain crazing. It was thought that the solution to the fault was to equate the expansions of body and glaze, and much work was done in studying the effects of glaze components on the expansion (or contraction) characteristics.

Shape of Ware Has Influence

J. W. Mellor[2] pointed out that when the body contracts more than the glaze, the latter is put into compression, and, when the reverse holds, into tension. The first condition conduces to peeling and the latter to crazing. He also examined mathematically the effect of the shape of the ware, and concluded that crazing was less likely on a curved than on a flat surface, but that peeling was more likely on a curved surface. Crazing was also more likely to happen with thick glazes. Practical experience confirms some of these conclusions.

Calculation of Glaze Expansion

It would seem, at first sight, that the determination of glaze and body expansions should enable a prediction to be made of the likelihood of stresses and strains being set up in cooling a glazed article. The difficulty of practical determination of the expansion coefficient is that, in the case of the glaze, the test-piece must be made by first melting the ingredients together. It is then reheated to determine the expansion characteristic. The assumption has to be made that no change occurs in the glaze itself as a result of the re-heating.

A. A. Winklemann and F. O. Schott[3] and S. English and W. S. Turner[4] and others have shown that the expansion coefficients of glazes can be calculated from a knowledge of the composition. To each component oxide can be assigned an expansion factor, and the total expansion is obtained by multiplying the percentage of each oxide by the appropriate factor and adding the results. The temperature at which a glaze solidifies, and therefore at which stresses and strains begin to develop, also depends on the glaze composition. It should be added that the subsequent behaviour of a glaze does not always agree with what might be expected from calculations. This is not unexpected, for the elasticity is an unknown factor and may be expected to vary with glaze composition.

Importance of Glaze Compression.

H. W. Webb[5] showed that to avoid

crazing with porous bodies it was important to put the glaze into compression and that the former idea that the glaze and body expansions should be equal was erroneous. The sudden contraction at approx. 220° C. due to the transformation of β to α cristobalite was shown to be of vital importance in generating this compression.

Previous observations that the total silica content of earthenware bodies should be greater than 73 per cent. (A. Heath[5]) and that harder biscuit-firing would improve crazing resistance were shown to be effective only as a result of increasing the formation of cristobalite in the free quartz in the body.

Moisture Expansion

One of the bugbears of the pottery industry has been the insidious form of crazing called "delayed." In 1929 H. G. Schurecht and G. R. Pole[6] showed that porous bodies in particular, expanded when exposed to atmospheric moisture. With vitreous bodies the expansion was still observed but on a very much diminished level.

The effect of this expansion is to offset any compression deliberately put on the glaze, and, in time, it may neutralise it and eventually put the glaze into tension. Crazing then occurs and the time required for this to happen will depend on the degree of compression put on the glaze initially, and the magnitude of the moisture expansion. It has always been assumed that the glaze itself exhibits no changes in volume as a result of after contraction or moisture expansion. Modern measurements show that these effects are very small and are negligible factors in delayed crazing. Thus L. Mattyasovsky-Zsolnay[7] showed that there was no appreciable change in the glaze stress of ware stored in a dry atmosphere for five years. He concluded that any change would have been due to after contraction in the glaze, since moisture expansion was prevented by the dry atmosphere. Since no change was recorded he concluded that after contraction was a negligible factor in delayed crazing. Evidently the reason for the relative freedom of vitreous ware from crazing is to be assigned to the relative absence of moisture expansion in the body.

The efficacy of the autoclave test for glazed ware depends very largely on the moisture expansion in the body produced by the action of the steam.

Autoclave Tests

Since the stresses or strains set up in a glaze are of such importance in its behaviour in service, the methods of measuring them are of some importance. In general one must differentiate between two types of apparatus for this purpose.

(a) that suitable for research work;

(b) that suitable for control of production.

For works control some simple and relatively inexpensive apparatus is required. This usually consists of some means of heating and cooling the ware, with or without steam, until crazing occurs. The result of such tests is then related to the known behaviour of ware in service, and used as a yard stick accordingly.

In general, heating and cooling cycles are too lengthy for routine tests and most factories nowadays subject the ware to the action of steam under pressure. As already pointed out, this superimposes the effect of moisture expansion on that of thermal shock. The methods adopted vary, some using hourly cycles of heating under steam pressures of 40-50 lb./sq. in. followed by immersion in cold water, and others continuing the heating under pressure till crazing occurs without cyclic cooling in water.

Modern work indicates that the effect of hot steam is much greater than that of hot water, and that the moisture expansion occurs mainly in the first hour or two of heating. It is important to allow the steam to penetrate to the body either through the sorting masks, or by grinding off a little of the glaze. Ten to twelve cycles of heating to 50 lb./sq. in. in steam followed by cooling in water is regarded as satisfactory for earthenware. Some ware attains twenty cycles before crazing on this test. Bone china and vitreous bodies attain even higher values. Wall tiles show a high moisture expansion and seldom survive more than six cycles of the above conditions.

L. Mattyasovsky-Zsolnay (loc. cit.) has suggested that 1 hr. at 150 lb./

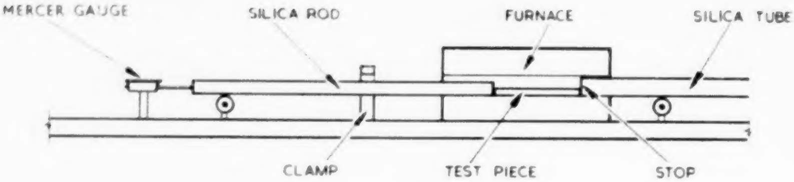

Fig. 1. Expansion apparatus

sq. in. steam pressure is equivalent to 3 hr. at 100 lb./sq. in. and that 1 hr. at 100 lb./sq. in. is equivalent to 4 hr. at 50 lb./sq. in. He concluded also that wall tiles which would stand 100 lb./sq. in. steam pressure for 2 hr. in the autoclave test would not craze in twenty years.

Modern research has shown that with wall tiles the pinch of the cement used for fixing in contracting during setting may be a more potent cause of crazing than purely manufacturing ones, and the use of mastic solutions in place of cement has been recommended. This is used in, e.g., America.

Determination of Thermal Expansions

Where adequate laboratory facilities are available it is possible to use more elaborate methods for determining whether a glaze is in tension or in compression. Mention has already been made of determinations of the coefficients of expansion of samples of the body and glaze. These are determined with a simple apparatus consisting of a fused silica tube fitted with a stop in which the sample is heated (Fig. 1). The tube is clamped at the open end and the heating zone is surrounded with a heating jacket made of electrical resistance wire covered with suitable insulation. One end of the test piece is held against the stop, which is fused into the tube, and the other butts on to a fused silica rod whose movement is recorded on a Mercer gauge. The temperature of the test piece is raised at the rate of about 200° C. per hour and the expansion noted at regular temperature intervals, these being recorded on a platinum thermocouple.

From these readings the coefficients of expansion at various temperatures can be calculated and the differences between body and glaze deduced. These provide an indication of the state of the glaze and whether it is in tension or compression, though it does not measure the magnitude of the stress or strain. G. E. Merritt and C. J. Peters[9] have made use of interferometric methods for expansion measurements on glazed ware.

Contraction Rings

Another popular method is the use of contraction rings. These have been described by H. G. Schurecht and G. R. Pole[10] and H. E. Davis and R. L. Linders.[11] The rings are 2-3 in. outside diameter when fired. The thickness is about ¼ in. and the height of each ring about ½ in. They are glazed on the outside only. Lugs are provided on the rings, and after firing suitable reference marks are attached to these, such as ball-bearings or pieces of skim brass. The distance between the reference marks is then measured with a vernier microscope and the ring is cut through between the reference marks. The shift in the

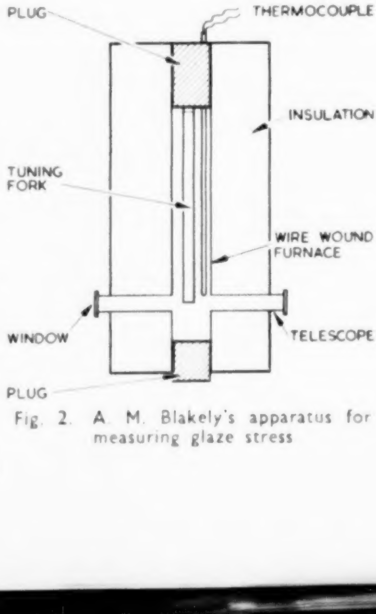

Fig. 2. A. M. Blakely's apparatus for measuring glaze stress

distance between the marks is again measured. If the glaze is in tension the marks will tend to spring apart and vice versa.

Bowing of Tiles

W. C. Bell[12] in a revue of the methods used in assessing glaze fit, describes another method involving the bending of a tile or flat plate (cf. Hagar and Schofield).[13] This was glazed on one side and, after firing, the bowing was measured by placing a horizontal metal bar mounted on legs on the tile surface, and measuring the bowing at various points with a Mercer type gauge fixed to the bar.

Bending Bar Method

W. Steger[14] used a thin piece of the body glazed on one side only. This was clamped horizontally in an electric furnace and heated, while the movement of the free end, due to the pull of the glaze, was measured by a pointer and scale. The biscuit piece was about 20 mm. wide by 3 mm. thick and about 200-300 mm. long. A depression on one side was filled with glaze and subsequently melted.

Later a telescope with graduated eyepiece was used to follow the bending of the test piece. Steger used this apparatus to study the behaviour of various types of glazes and bodies.

Tuning Fork Method

A. M. Blakely[15] used a similar apparatus and developed formulae which enabled calculations to be made of the stresses and strains in glazes from measurements of the movement of the arms of a tuning fork made from a body and glazed on the outer edges. The tuning fork was made from two extruded bars of the body about 6 in. long by $\frac{3}{16}$ in. thick. The arms were separated by a piece of the same extruded body $\frac{3}{16}$ in. thick and the whole was stuck together with slip and biscuit-fired. The outside faces of the fork were then sprayed with glaze and glost-fired. Reference marks were then placed on the inside faces of the ends of the fork with refractory cement and it was hung vertically in an electric tube furnace (Fig. 2). This was fitted with windows so that the movement of the reference marks could be observed in a telescope.

The furnace itself was built from a refractory tube wound with No. 26 gauge platinum wire. It was surrounded by a wider one and the space filled with suitable insulating material. A thermocouple placed alongside the specimen recorded the temperatures. It is not necessary to use platinum wire since no very high temperatures are required, and nickel-chromium or kanthol alloy wires can be used.

Blakeley developed formulae for calculating the stresses in body and glaze from measurements of the deflection of the arms of the tuning fork. The derivation of these is outside the scope of this article, and for full details the reader is referred to the original paper. In this way it was possible to obtain values for a number of glazes and bodies over a variety of temperatures from the point where the glaze hardens. Above this of course, the glaze is molten and not under stress. The results were plotted against temperature to give stress or strain curves.

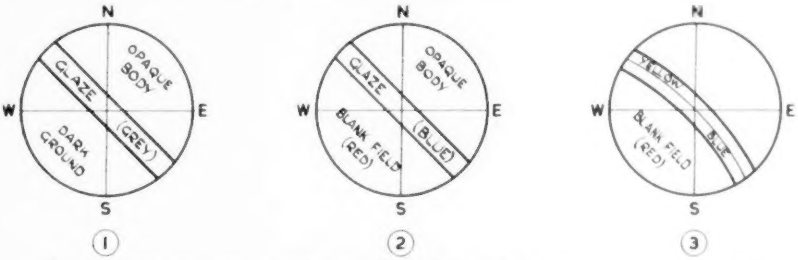

Fig. 3. Indicating: (1) Section in N.W.-S.E. position seen through crossed prisms. (2) Section in N.W.-S.E. position see through crossed prisms with gypsum plate inserted. (3) Appearance of glass thread viewed through crossed nicols and gypsum plate, showing method of determining whether glaze is in tension or compression (after Smithson)

Another useful qualitative method of determining whether a glaze is in compression or tension is by the use of the polarising microscope. This has been described in some detail by F. Smithson.[10] In this method a slice is cut through the glazed body 2-3 mm. thick using a diamond-impregnated wheel. Both sides of the piece are then ground down with silicon carbide paste until the slice is about 1 mm. thick. This slice is then placed on a slide and viewed under a microscope with the polariser in the crossed position. The glaze is placed in the slide so that it runs NW-SE with reference to the cross wires in the eyepiece. Strain in the glaze is indicated by a light appearance on a dark ground (Fig. 3).

To determine whether the glaze is in tension or compression the gypsum plate is then inserted. The glaze section may then appear blue or yellow, and rotation through 90° will change the colour from one to the other. To determine whether the blue indicates tension or compression when the glaze is viewed in the NW-SE position Smithson recommends taking a glass fibre and inserting it in the same position on the microscope slide. On bending it the concave edge will be in compression and the convex in tension. The colours seen in the fibre will show whether the blue indicates compression or tension and vice versa. This method is useful in indicating qualitatively stresses and strains in glazes.

The obvious disadvantages are that the test is a destructive one and that it will not work with opaque glazes. With highly-coloured clear glazes the results obtained are not straightforward. The specimen should be immersed in oil or mounted in Canada balsam, since under dry conditions it is possible to get colours indicating slight tension where none exists. Glass abnormally high in lead also give anomalous results, but this does not occur in the range of compositions used for ceramic glazes.

Results of Determinations

Whichever method is used in examining glazes, all the results point in the same direction, namely that with porous bodies especially the glaze should be in compression to avoid crazing. The degree of compression necessary will vary with the composition of the body, which in turn influences its moisture expansion.

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(*Bibliography continued in February.*)

The Regalia pictured here was presented to Mr. D. N. S. Salt, president, British Pottery Managers' and Officials' Association, on the occasion of Annual Dinner held in Stoke-on-Trent on 13th December, 1952. The President thanked the designer and Mintons Ltd., who arranged for its manufacture, and Mr. Unwin and Mr. Nabay who guided the potting and decoration

German Ceramic Conference 1952

ON the eve of celebrating its 40th anniversary, the "Deutsche Keramische Gesellschaft e.V." (German Ceramic Society), recently held its 1952 Conference at Goslar, old imperial city hidden in the Hartz mountains, mountains which have been made famous by the legends of the Valkyrie.

If the existing D.K.G. under its present name, came into being on the 29th September, 1919, less than a year after the cease-fire of the first world war, its real beginning goes back to 1913, when a Commission of Technical and Scientific Studies was formed within the Federation of Ceramic Industries. In 1919 the D.K.G. formed an independent group made up of all the specialists in the industry, from the manufacturers of bricks and tiles to those of fine porcelain.

Record Membership

Following the second world war it was not until 1949, after the formation of the Federal West German government, that Mr. Guillaume, Doctor of Engineering from Beuil, was able to gather round him at Bonn, the new German capital, the remnants of the old D.K.G., with a view to once more going ahead. Thanks to his unceasing and untiring work, and to that of his colleagues, great strides forward are now being made. At the conference at Bayreuth in 1950 there was an attendance of more than 400. At the spa of Bad Neuenahr in 1951, there were more than 600, whilst in the spring of this year, the D.K.G. enrolled its 1,100th member, thus reaching its record number of 1929.

These figures give an idea of the work achieved by the D.K.G., its directors, Dr. Guillaume and his colleagues, and last but not least Mr. Rechenberger, the managing director of the Society at the registered offices in Bonn, rue Reuter.

At the 1952 Conference held at Goslar there were nearly a 1,000 people: many members came with their wives as well as a number of foreign guests including, Professor Yves Letord of Paris, Professor Andreasen, Mr. Berg, engineer, from the Royal Copenhagen Polytechic, Professor Arvid Hedvall, Doctor of Engineering from Goteburg, Sweden; Mr. Francesco Merlini, Doctor of Engineering from Quinto, Firenze, many businessmen from Sweden, Denmark, Holland, Italy, Switzerland, and from France, the specialist in silk screen printing, Mr. Dubuit of Paris. The Federal Government was represented by Dr. Seger-Kelbe of the Ministry of National Economy, whilst many Polytechnics and Schools were represented by their distinguished professors. The School of Mines at Clausthal sent some of their students.

Tuesday, the 23rd September was reserved for meetings of the different committees and sub-committees; on Wednesday, the 24th, there was a Board Meeting, followed by the Annual General Meeting. Then, in the late afternoon, in the big festival hall of the "Odeon," the conference was solemnly opened. There was music by the Goslar Symphonic Orchestra, and a speech by Professor W. Oelsen of the Academy of Mines at Clausthal, member of the Max-Planck Institute on "The Science of High Temperatures, from the Technical point of view, Research, and Teaching."

Technical and Scientific Discussion

The 25th September was a day of meetings, with technical and scientific discussions held in the great marble hall of the Achtermann Hotel. This old inn, completely modernised, is built on the ancient ramparts of the town, close to the famous tower from which it takes its name. This was a very interesting and instructive day, and the hall, although large, was scarcely big enough to accommodate the number of people who attended.

First Mr. Lunghard of Selb spoke on the question of "The Worker in Relation to Industry," then Professor Bontjes Van Beek from Dehme-Bas Oeynhausen on "Art and Science in Ceramics," followed by Dr. Adalb. Klein of Dusseldorf on "Contemporary Ceramics," whilst Wim Muhlendyck from Hohr-Grenzhausen (a well-known centre of potteries, situated in Westerwald, near Coblenz) spoke about "Problems of the Workshop."

Two very interesting lectures were given by Professor Andreasen and Engineer Berg, both of the Royal Copenhagen Polytechnic, on "The Comparison of Different Methods of Determinating Specific Surfaces" and "The Influence of Mixing Fine or Coarse Clay on the Quality Before Baking."

Then Mr. Dubuit, Eng. E.P.C.I. of Paris, gave a speech on "Progress Made in Machinery for Printing Ceramics by the screen Process in Mass-production." This was of great interest to many listeners, as this method of decoration, although used by the German glass industry, is not well known in the ceramic industry. There is no doubt that this new process opens up wide fields for the ceramic experts, and they were greatly impressed by the films following the lecture. These films showed the decoration of pots, ashtrays with four or six sides, plates in biscuit being printed on the base and border simultaneously in two colours, etc. Another film, followed with no less interest, although primarily intended for the glass industry, showed bottles being decorated at a speed totally unsuspected up to date. The last film showed the latest presentation of Machines Dubuit, the new machine for printing bottles by the use of thermoplastic enamels. These enamels, solid at ordinary temperatures, melt at 50 to 100° C., and after passing through the screen, which made of metal mesh, acts as an electric element, solidify immediately on the object to be decorated, thus allowing the printing of a second colour directly after the first. The lecture was greatly praised to the honour of Mr. Dubuit, and also the French ceramic industry, whose members revealed many modern installations, etc., at the recent International Ceramic Conference held in Paris.

Professor Ulr. Hofmann of the Darmstadt Polytechnic spoke on the "Effects of Thixotrophie," whilst Mr. J. Schuffler of Dusseldorf gave a lecture on "Duty of the Planner and Builder in avoiding the Dangers of Silicose." Professor A. Dietzel, a great ceramic expert, referred to the question of "Transparency in Porcelain in Relation to the Quality of Quartz Utilised," whilst Eng. Lutsch of Erlangen ended this series of discussions with a study on "Testing High Tension Porcelain by Sound Rays."

This was a most instructive day, as we have already said, and was followed by private exchanges of ideas between lecturers and listeners, in which suggestions and advice were given, all without any distinction of nationality, and with one common aim.

NEW TYPE DUTCH FLOWER POTS

TWO new types of flower pots have recently been evolved in Holland with the idea of providing better ventilation and regulated water supply for plant growth.

One of these, known as the "Walu" pot and designed by a well-known pottery artist A. D. Copier, consists of the pot itself and a saucer in which it stands. Instead of having the normal flat flower pot base the under part of the pot is curved, and, as well as having the usual central opening at the perimeter of the curve, also has a number of holes for ventilation purposes. Also incorporated into the base of the pot are four supports on which the pot stands. Extending slightly beyond the curve of the base, these allow a small space between the latter and the inside of the saucer. When water is poured into the saucer it covers the bottom hole of the pot but does not reach the ventilation holes since they are higher than the maximum water level of the saucer. In this way both water and air can be absorbed by the plant and the soil is kept sweet and wholesome.

This pot is made of a material of fine granulated structure known as "Graniver" and, greenish-yellow in colour, is made in four sizes.

The other pot has been produced by a well-known Dutch glassworks in co-operation with Prof. A. M. Prenger, of the Wageningen Agricultural College. It is made up of an outer glass container and an inner porous pot which is glazed on its outer surface, with the exception of the base through which moisture can be absorbed. When the fine porous inside pot is placed in the glass container it rests on a number of ribs and the space between the two is filled with water. Moisture is taken in by the plant as required from the porous walls of the inner pot. While it will thus always have sufficient water so long as there is water in the glass container the plant will not absorb more than it needs.

The level of the water can always be seen through the glass and it is possible to couple up several of these "Provista" pots in series, by means of glass syphons, with a reserve water supply. In this way they can be left for quite long periods without attention.

Both of the new pots are being made by the N. V. Nederlandsche Glasfabriek Leerdam, of Leerdam, South Holland.

CONTINUOUS BRICK KILNS

by CHARLES HILL

It is now nearly a century since Hoffmann introduced his continuous brick kiln into this country. At that time there was urgent need for better means of burning bricks. Brick machinery had been introduced a few years earlier, and the continuous kiln opened up the possibility of year-round brickmaking with a lower fuel consumption than had before been possible.

Circular in shape, with central chimneys, there are still a few of these old-time Hoffmann kilns, delivering bricks to the tune of nearly 100,000 per week. It is to this original idea that numerous complications and trimmings have been added by later designers.

Hoffmann, however, was the first to apply the principle of regeneration to brick-burning, using cooling bricks as a regenerator, and passing on the heat thus picked up for use in the firing and drying of bricks in another part of the kiln. All other developments in such kilns are subsidiary to Hoffmann's original idea, which reduced fuel consumption to one-third, and in some cases to one-quarter of that used in intermittent kilns for the same amount of work.

Modern Kilns and Methods

Today's kiln designers usually build to suit the available raw material—for it is on this that both output and quality depend. Although much may be done to alter the nature of the raw material, in the main it is on the right choice of kiln that success or failure will rest. He will be a happy man who can choose a kiln to meet the requirements of his own particular circumstances; for with the right kiln a brickworks is already half-way to success.

Methods of firing continuous kilns include feeding by hand, or use of automatic stokers. Firing may be on to a dead-bottom furnace, on to a grate, or into channels supplied with primary air. In addition, fuel may be fed either from ground level or, according to requirements of design and of the goods to be fired, from a firing floor situated over the chamber arches.

Draught

Draught, which has been called the life breath of the kiln, may be produced naturally by chimney, or artificially by fan. In positioning a chimney or fan this should be set off-centre on one side or other of the kiln, and should be positioned half-way along the kiln's length. Such a position evens up the "pulling" power of fan or chimney. If, on the contrary, the fan or chimney is erected at one end of the kiln, there will be times when vapour and products of combustion will have to travel long distances to reach the fan or chimney. In these circumstances more power will be used by the fan, or more coal will be consumed in maintaining temperature at the chimney base.

In these days few designers recommend chimney draught. This, requiring as it does, a well-built chimney up to, say, 180 ft. in height, is a costly business. The school of thought which believes that chimney draught is cheaper than use of a fan is hopelessly mistaken. No part of a works is more neglected than its chimney shafts, and as chimney draught is operated by the consumption of fuel, neglect adds considerably to this cost. Briefly, since a chimney uses the energy from the hot gases of combustion as the source of its power, the draught will vary according to the amounts of heat energy in the products of combustion.

A few of the patterns now in use.

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On the other hand, while the cost of fan draught is easy to compute, knowledge of *kiln* fan draught is far from complete. There are cases which call for fans capable of extracting 30,000 c. ft. of air and gases per min. for an output of 90,000 bricks per week. Another fan, however, will need to extract only 20,000 c. ft. per min. for a much greater output.

Power Costs and Primary Air

The cost of power consumed, lubricants, etc., are set against fan draught, but it is too often overlooked that heat is wasted in producing chimney draught and heat costs money. The writer believes that a properly designed fan provides the most economical means of producing draught. Compared with a chimney, a fan gives a higher finishing temperature, coupled with the highest possible transfer of heat to bricks from the fuel consumed. Other advantages which accrue are cooler working conditions for burners, setters and drawers both in summer and in winter.

In the writer's opinion every continuous kiln should have a primary-air arrangement. Such can be successfully fixed up in continuous kilns of whatever type. The secret of success with these arrangements lies in keeping flues and grates free from ashes, dust and heavy clinkers.

By their use the quality of goods can be expected to improve, and faster fire-travel to result from the highest possible production of heat from the fuel used. Properly used, primary air gives complete combustion, leaving only incombustible material in the grates. Should these airways be neglected, however, and left to chance, the quality of goods is likely to decline. Fire-travel is then reduced, trouble comes to the burner, and cleaning out the arrangement is an ordeal of dust, fire and fume.

Long and Narrow Kilns

The circular Hoffmann kiln reigned supreme from 1856-1866 when the first Zig-Zag kiln was introduced by one Arnold Bührer. Compared with the Hoffmann it was of massive construction with its firing tunnel arranged in a manner which ensured an extremely long fire-travel.

Inside the kiln, long, narrow chambers are so constructed as to cause the fire to travel in transverse direction to the centre wall of the kiln and, in alternate chambers in transverse direction towards the outer kiln wall. Therefore, the firing-tunnel doubles back upon itself—hence the name Zig-Zag.

In such a kiln, with its narrow face of fire, fan draught is ideal, and a high chimney is no longer required. Fire-travel is rapid, and the kiln has great heating capacity. Under good conditions it is possible to fire and finish twenty-eight chambers in a week. In the writer's opinion the Zig-Zag is a good kiln, and from it engineering, facing and common bricks can be obtained.

Mistakes regarding Zig-Zag outturn, however, are common, and the following serves to illustrate this point. In an average Zig-Zag kiln of twenty-eight chambers, weekly output would probably be about 250,000 bricks; while a kiln of another design could deliver 300,000 bricks from only ten chambers. The reason for this, of course, lies in the difference in the chamber capacity of the two kilns. Fuel consumption in the Zig-Zag kilns, however, would be smaller because the fire moves too rapidly to allow of much loss of heat by conduction into walls and arches.

English Kilns

The "Ideal" kiln is an English kiln having a long, narrow, barrel arch. In this kiln the sub-flues to the main air-passage act in a dual capacity: first as an exit for vapour and combustion products; and later as a channel furnace supplied with primary air.

The main flue to the fan or chimney runs underground up each side of the kiln in lengthwise direction. This is exposed to the weather, and as it requires heating up at each round of the kiln, this may cause a heavy charge on fuel or power as the case may be.

Situated on the middle line of the wicket is a furnace equipped with a drop arch 3 ft. back. This necessitates a stepped-back setting of the green bricks, and reduces capacity by one-third.

From this kiln the writer has pro-

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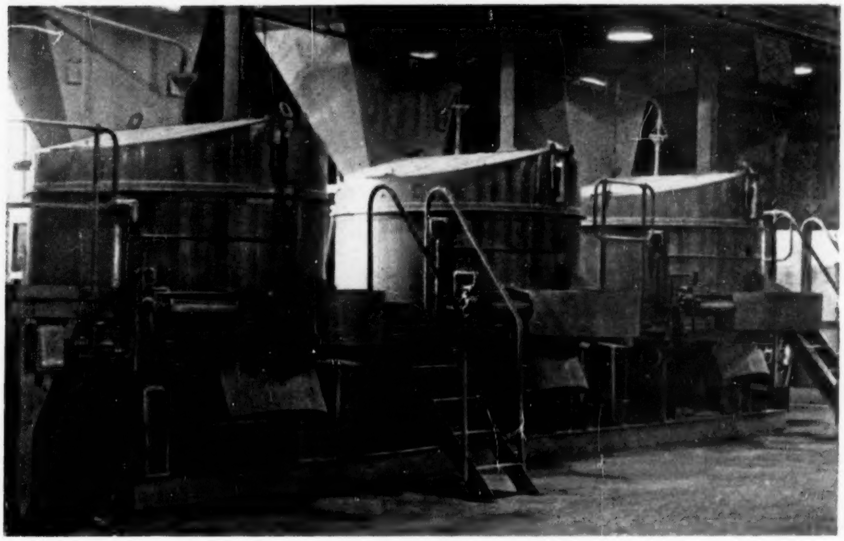

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Other Narrow Kilns

Two other long, narrow kilns are the "Improved Belgian" and "Brown's Patent" respectively.

The Belgian can work as an endless tunnel kiln or, like the Brown, it can be partitioned either into sections, or into single chambers.

Brown's kiln is fired from a floor over the arch top, through feed holes into a channel furnace supplied with *heated* primary air. It can deliver roofing tiles, land drains and engineering, facing and rustic bricks of many colours—including grey, blue, brown, buff and gold. This kiln may be arranged to use both the heat from cooling chambers, *and* the hot products of combustion, for drying heavy clayware in a specially constructed dryer.

The Belgian kiln is grate-fired from ground level, and when used as an endless tunnel is suitable for the production of firebricks and engineering bricks of great strength.

Archless Kilns

The first archless continuous kiln was designed by Otto Bock in 1895; and from the point of view of a practical man it would seem that the archless kilns then designed were a better job than some which came later on.

There are many differences between arched and archless kilns. The Bock archless is similar to the Hoffmann, and the Bull, another archless kiln is popular in India. In passing, Bull's method of brick-setting used in English kilns has been known to work when everything else the burner could think of had failed.

Both Bull and Bock kilns differ from the Hoffmann in that they were always worked with *top draught*. Otto Bock describes the method in his book on kilns, pointing out that top draught gives quicker fire travel and better goods. It is possible to fire facing bricks in archless kilns, but, by and large, they are intended as cheap substitutes. Cheap to build, they cool quickly and have more natural light than more conventional kilns.

Burners find archless kilns excessively hot to the feet, suggesting great loss of heat. And there is a hot, dusty job in removing and replacing temporary arches. Writing as a practical burner, the author believes that archless kilns are nothing more nor less than monstrosities which should never have been built.

Lancashire Kilns

Mass production of common bricks calls for a Lancashire kiln. Its chambers are wide, high and long, and the kiln is capable of an outturn of 250,000 to 300,000 per week from a single face of fire. The Lancashire has transverse arches, with wickets wide enough to allow lorries to back inside the kiln for loading, thus giving a quicker turn round for transport than is possible by some other methods.

In addition, the wide, high wicket opening assists in quick cooling, and this advantage, coupled with speedy loading of finished bricks outweigh any disadvantages that may present themselves to the thoughtful reader.

The Super-Staffordshire Kiln

The Super-Staffordshire kiln is a grate-fired transverse-arched type fitted with a primary-air arrangement. This latter has an arched passage for incoming air of about 3 ft. in depth, with openings in the kiln floor under each feed-hole covered with fire bars.

Such a deep primary-air flue saves cleaning under the grates at every round of fire and, therefore, the flue is seldom blacked, which is something that cannot be said about many other types of grate-fired kilns. But where quality is desired, clean flues are essential.

Another transverse-arched kiln is the Staffordshire, with slotted partition walls allowing the burner to lower thin damper plates behind the fire to control the creep of cold air.

Then, too, when a chamber of freshly-set goods is sealed, similar thin plates may be lowered from the kiln top to seal the partition passages. In this way, the burner can isolate the drying bricks, keeping out the products of combustion until drying by clean, hot air has made progress. Following this, the burner can withdraw the plates one by one at pre-

determined intervals, admitting hot products of combustion by degrees, thus preventing sudden rises in temperature and the danger of condensation on the drying goods.

Developments

From the foregoing it will have been seen that since the first circular Hoffmann there have been developed kilns of greater length or width or both. Today, the designer allows room for all stages of burning, including setting, drying, pre-heating, firing, cooling and drawing. Working lengths have been increased and every stage can now be worked on its own instead of, as was formerly the case, one stage working at the expense of another.

Taking the Hoffmann of modern design as an example. Main flues are spacious, and sub-flues roomy. Such a kiln is flexible enough to be adapted to many materials and products. If required, it can be equipped with grates or fire channels, and a primary-air installation.

Its hot-air-flue is sufficient in size to be highly useful during drying. In addition, where firing materials are being made into bricks, walls can be built to allow of isolating either an individual chamber or groups of chambers when desired.

Such a kiln is flexible enough to be used for firing hollow clay block, drain tile, common, facing, and engineering bricks. Additionally, surprising as it may seem, the writer has successfully fired fireclay goods at 1,250°-1,400° C. in what was nothing more than an adaptation of the common or garden Hoffmann.

After forty years as a burner, the writer is convinced that economic outputs are obtainable only from well-designed kilns, well-prepared materials and uncrowded setting. All these are essential to the successful firing of bricks—as are experience, a sharp eye, and an interest in the job.

Change of Address.—The Information Branch of the Ministry of Fuel and Power has now been transferred to Thames House South, Millbank, S.W.1. The telephone number (Abbey 7000) will be unchanged.

OPTICAL GLASS

By

R. H. WARRING

OPTICAL glass, as such, has not been manufactured as a commercial material for much more than half-a-century, yet glass itself was known and used thousands of years before the birth of Christ. There is a considerable difference between ordinary commercial glass and optical glass, or glass produced especially for optical instruments. For one thing optical glass is made only from the purest of raw materials, usually in relatively small quantities at a time and under very carefully controlled conditions. Ordinary sheet glass, by comparison, is usually produced in the form of a continuous sheet, day and night, without stopping, from automatic machines which may go on working in this fashion for three years or more before they are finally stopped for maintenance and repair.

One of the main reasons why optical glass was not considered a commercial proposition until fairly recent years was that the demand was limited. To make the small quantities that were required called for skill, time and patience out of all proportion to the size of the market. Early experimenters had to make do with the best of what commercial glass was available, selecting the bottoms of goblets and similar containers, for example, for lenses.

The basic ingredient of all glass is silica (SiO_2) or sand. Some sands contain a higher percentage of silica than others, but even the best white sand usually contains no more than 99 per cent. silica, with traces of iron oxide and other impurities. Metallic oxides, fused with the silica during manufacture, usually impart a colour to glass. By far the commonest impurity is iron oxide, usually retained in the ferric state, resulting in a characteristic green colour. To produce a commercially pure "white" glass, decolorising agents such as manganese dioxide are added to the basic mixture. Manganese oxide on its own produces a light purple colour in glass. Since purple is complementary to green the combination of colour effects is neutral or "white."

Whilst this method of treatment may be perfectly satisfactory for windows and the like it is quite unacceptable for optical work. Hence the importance of starting with chemically pure constituents for the

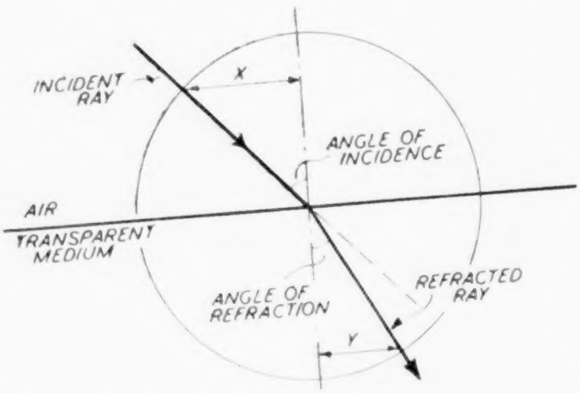

Fig 1

TABLE 1. VISIBLE LIGHT SPECTRUM

Colour	*Variation Range cm. (YW^{-5})*	*Frequency (c.p.s. × 10^{12})*	*Standard*	*Symbol*	*Wavelight*
Red	7·5-6·5	394-463	Helium	b	7·0652
Orange	6·5-5·9	463-509	Hydrogen	c	6·5628
Yellow	5·9-5·3	509-545	Sodium	D_1	5·8959
			Helium	d	5·8756
Green	5·3-4·9	545-609	Mercury	e	5·4607
Blue	4·9-4·2	609-658	Hydrogen	F	4·8163
			Mercury	g	4·3583
Indigo (violet)	4·2-4·1	658-697			
Violet (Par violet)	4·1-4·0	697-833	Mercury	h	4·0466

original mixture from which the optical glass is fused. A typical limit for certain types of optical glass is a maximum of 0·017 per cent. iron whereas ordinary commercial glass may contain many times this proportion.

Particular characteristics required of optical glass, in addition, are that it should be homogenous, so that the refractive index and dispersion can be accurately determined. A high degree of transparency is also required, sometimes to wavelengths outside the visible spectrum.

The optical properties are largely determined by the chemical composition of the glass. Light itself is a wave motion with a nominal speed of 186,000 miles per sec. This velocity is decreased when light passes through any transparent medium. It is slightly less in air than in outer space, for example, and appreciably less when passing through glass. This retarding effect produces a bending of the light rays incident to the surface of the transparent medium, known as refraction, Fig. 1. The simple definition of the measure of refraction of refractive index is then the ratio **x** : y, or sine angle of incidence: sine angle of refraction.

TABLE 2. OPTICAL GLASS TYPES

	Type of Glass	*Standard Code*
Flint	Extra light flint	ELF
	Dense flint, etc.	DF, etc
	Telescopic fiint	TF
	Barium light flint	BLF
	Barium flint	BF
Crown	Light barium crown	LBC
	Medium barium crown	MBC
	Dense barium crown	DBC
	Boro-silicate crown	BSC
	Soft crown	SC
	Hard crown	HC
	Floor crown	FC

The refractive index is actually a measure of the retarding effect on the velocity of light produced by the transparent medium and is numerically equal to the velocity (of light) in a vacuum (or air, for all practical purposes): velocity in the medium. This is simply illustrated by Fig. 2 which shows a beam of light refracted

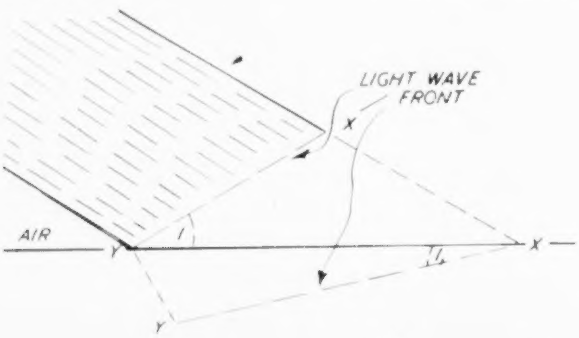

Fig. 2

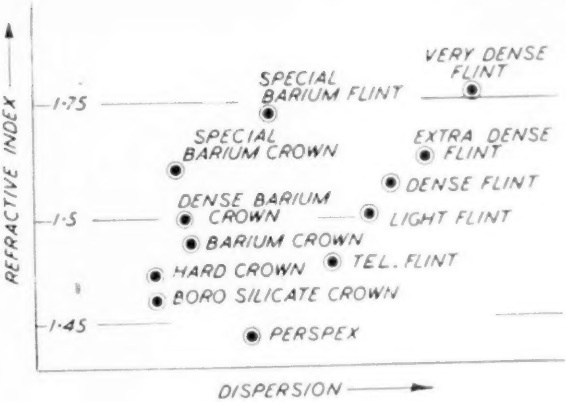

Fig. 3

at the surface of the air and transparent medium. The time the light beam takes to travel the distance X-X in air, it travels Y-Y in the medium. The ratio X-X : Y-Y is the same as the ratio of the sines of the angles of incidence and refraction as defined previously; or the velocity ratio is the same as the refractive index. Now for a given homogenous transparent medium the refractive index will vary with the wavelength of the light. Normal "white" light includes a range of wavelengths from about $4·0 \times 10^{-5}$ cm. to roughly $7·5 \times 10^{-5}$ cm. (see Table 1). The red light band in the visible spectrum will be refracted less than violet, on account of its longer wavelength and the difference in refractive index for different wavelengths is called the dispersion or the dispersive power of the medium. Numerically this is defined as the ratio $\frac{n_1 - n_2}{n_3 - 1}$ where the suffixes 1, 2, 3 refer to light in the blue, red and yellow wavebands, respectively, as fixed standards. Where a single refractive index is quoted this is usually referred to a specific wavelength in the visible spectrum, usually yellow light wavelength $5·8756 \times 10^{-5}$ cm. (produced by a helium source as standard).

Some idea of the effect of chemical composition of the glass on these two

TABLE 3. TYPICAL REFRACTIVE INDICES*

	Type of Glass	*b*	*Refractive Index* D_1	*e*	*F*	*h*
Flint	TF	1·52557	1·53033	1·53289	1·53753	1·54786
	BLF	1·56224	1·56702	1·56959	1·57433	1·58476
	FLF	1·54211	1·54757	1·75054	1·75612	1·76868
	BF	1·63837	1·64446	1·64776	1·65394	1·66776
	LF	1·57212	1·57846	1·58193	1·58850	1·60350
	DF	1·61473	1·62240	1·62667	1·63478	1·65357
	EDF	1·64232	1·65088	1·65567	1·66482	1·68624
Crown	FC	1·47940	1·48272	1·48442	1·48752	1·49409
	BSC	1·51367	1·51749	1·51949	1·52316	1·53106
	HC	1·51280	1·51681	1·51893	1·52282	1·53126
	LBC	1·53630	1·54056	1·54282	1·54696	1·55595
	MBC	1·56748	1·57210	1·57456	1·57910	1·58899
	DBC	1·58406	1·58857	1·59097	1·59535	1·60481
	SC	1·51087	1·51508	1·51732	1·52146	1·53058
	Special BC	1·64569	1·85088	1·65365	1·65873	1·66975
	Special BF	1·73623	1·74383	1·74795	1·75567	1·77292

* *Typical figures for Chance optical glass*

TABLE 4. COMPOSITION OF TYPICAL OPTICAL GLASSES[1]

		SiO_2	Na_2O	B_2O_3	Ab_2O_3	K_2O	PbO	As_2O_3	ZnO	BaO	ThO_2	Ca_2O_3
Crown	Medium barium crown	46.5		4.5	4.1	4.0			8.0	32.3		
	Dense barium crown	33.5		7.9	3.7			0.4	5.4	48.9		
	Special Barium crown	10.5		24.3					4.0	27.0	13.3	18.5
	Boro-silicate crown	70.6	3.9	8.8		16.1		0.2				
Flint	Light flint	72.8				9.4	37.2	0.2				
	Dense flint	45.1	4.8			3.4	45.9	0.4				
	Extra dense flint	40.5	2.1			4.9	52.0	0.6				
	Special barium flint	15.2		15.4			9.0		2.5	31.3	11.3	13.0

1 Home Dickson

major optical features can then be given in diagrammatic form, as in Fig. 3. Normal glasses, even in the purest state, have optical properties which are not particularly desirable and thus have limited application in the development of high-class lenses. Theoretically it is possible to draw up a glass composition which will have the desired optical properties, but practical limitations as regards manufacture may then intervene, calling for a compromise. Some of the modern optical glasses of unusually high optical quality have necessitated special production technique, including the use of electric furnaces and platinum crucibles instead of the normal fireclay pots for melting. This is because certain of the chemical ingredients used have a corrosive action of the refractory materials normally used for the melting pots.

In technique optical glass manufacture follows the "classic" method of melting glass in open pots more closely than modern automatic and semi-automatic methods now used for the large scale manufacture of commercial glass. The one important difference in the basic process, however, is that the molten glass mixture is thoroughly stirred in an attempt to produce a homogenous fluid. Even this is not entirely successful and the resulting cast glass is broken up into small slabs and selected for further treatment, or rejected, by visual examination. Satisfactory material is then re-heated and moulded into lens or prism blanks, and so on, and then annealed to relieve any internal stresses introduced by the various heat treatments. Annealing consists basically of raising the temperature to a certain fixed figure and then allowing the glass to cool down very slowly at a rate of something less than 1° C. per hr. The ultimate optical properties of the glass are affected both by the chemical composition itself and the subsequent thermal history during manufacture, casting, moulding and annealing. These properties are then accurately fixed by such instruments as the spectrometer and refractometer.

Variable Speed A.C. Motor. We have received from Laurence, Scott and Electromotors Ltd., 431 Grand Buildings, Trafalgar Square, London, W.C.2, a revised publication dealing with the N-S variable speed A.C. motor. Illustrations in the booklet indicate many fields of use, including boiler house, pumping station and gas booster drives, as well as many applications to industrial drives.

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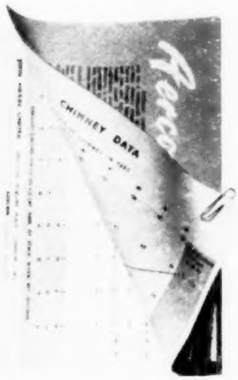

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The Mechanical Edge Lining of Tableware

By

TOM WATHEY

IT has long been the practice of the pottery manufacturer to decorate articles of tableware with lines and bands of gold or of coloured enamels. Such are applied in a variety of combinations: on ware faces and, in particular, on the extreme edges of articles both hollow and flat. In addition, when other types of decoration are used, thus making face lines superfluous, the edge line is still desirable in that it adds character to the piece by clearly defining and emphasising its shape.

The edge line, then, may well be considered an essential feature of a wide variety of decorated articles of tableware. And in this regard, in recent years, considerable success has been achieved by the precision ceramic engineer in providing mechanical means of carrying out the gold edge-lining process. So far, however, a solution to the problem of applying ceramic enamels by similar means has eluded both engineer and chemist. But it can be claimed that sufficient progress has been made to enable the experimenters to prophesy success in the reasonably near future.

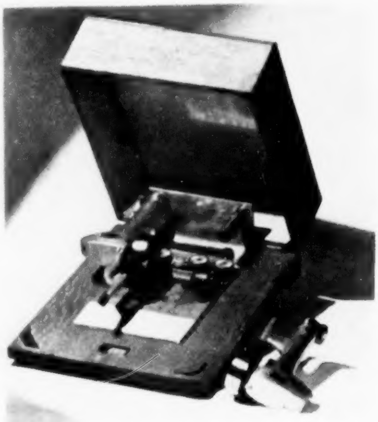

Fig. 2. Standard applicator in storage box, with spare rubber rollers

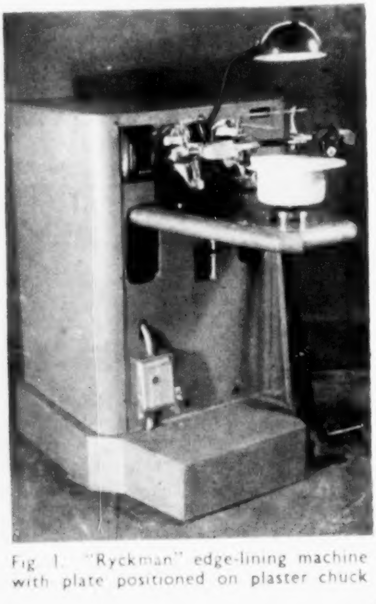

Fig. 1. "Ryckman" edge-lining machine with plate positioned on plaster chuck

An Edge-lining Machine

One of the machines which has been developed for the specific purpose of applying gold lines is the "Ryckman" edge-lining machine (Fig. 1) from which the quality of work produced is claimed to be of a consistently high order. In addition, where the edges to be lined are of an irregular nature as, for instance, scalloped or crinkled only the most highly-skilled hand workers

are able to equal the results obtained from the "Ryckman," while from an output point of view it is said to be quite impossible for hand workers to compete with the machine. In general, the machine is stated to be capable of an output approximating to some two to three times that resulting from hand methods.

It may be added here that the "Ryckman" is also adapted to the production of stippled edges of up to [illegible] in. in width. But in comparison with a plain edge-line, output is reduced by about one-third.

Fig. 3. Three-point chuck for holding cups and similar articles

Same Features

As may be appreciated, the most important feature of the machine is the means by which the liquid gold is transferred to the work piece. The gold solution is, in fact, rolled on to the edge of the article with which it is brought into contact by means of a small rubber roller. This latter is fed, in turn, with liquid gold from a hardened and precision-ground colour drum incorporated in the applicator unit (Fig. 2) of which there are two to each machine.

The specially compounded liquid gold, in small quantity, is contained in a small reservoir which forms an integral part of the applicator unit. From this reservoir the gold solution is metered to the steel colour drum by means of an adjustable tungsten-carbide scraper blade, which transfers the precious liquid to the rubber applicator roller. The amount of gold to be applied is thereby precisely controlled, and wastage is reduced to the minimum.

Another feature effecting economy is the fact that only a very small quantity of gold solution is exposed to atmosphere at any one time. Thus, the evaporation of essences contained in the solution is negligible.

Output

The colour drums of the applicator units are positively driven by flexible shafts from a motor and gear-box combination, and the speed of rotation may be varied by means of a three-speed cone pulley. It is possible, therefore, to obtain slower or faster speeds of the actual applicator rollers, as these are friction-driven from the colour drums.

In processing a plain, circular edge the fastest speed of application—

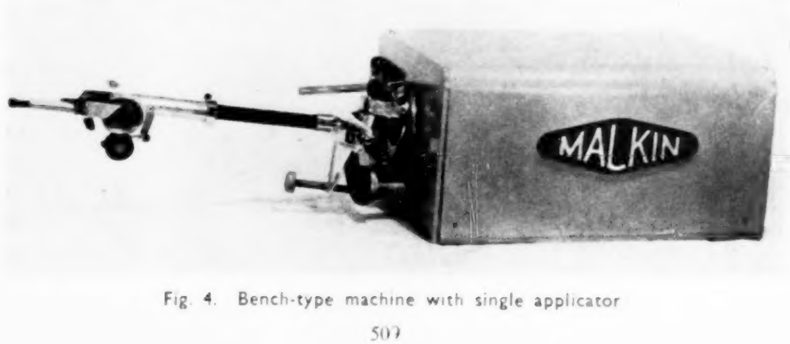

Fig. 4. Bench-type machine with single applicator

600 linear in. per min. may be used. But for more difficult shapes it may be found necessary to reduce speed by changing to another cone pulley, thus reducing linear speed to, say, 400 in. per min. The work-piece itself is rotated by contact with the friction-driven applicator rollers, and it is obvious, therefore, that plates of large diameter will take correspondingly longer to process than smaller ones.

If a small plate having a plain, circular edge of 20 in. circumference were being lined at the usual speed of 600 linear in. per min., it would rotate at 30 r.p.m. At this speed, and allowing for a minimum of two revolutions to produce a satisfactory line, the lining operation would take 4 sec. And a further allowance of 2 sec. loading time gives a total time-cycle of 6 sec. per piece.

On this basis it can be calculated that some 400 × 12 articles of 6 in. in diameter can be processed during the usual 8-hr. day. Outputs of articles having larger or smaller diameters may be calculated in the same way. But it should be borne in mind that fancy edges may necessitate a reduction in speed of application, with a corresponding reduction in output.

Chucks, etc.

During the operation of edge lining, articles of flat ware are carried on a simple, plaster support or chuck—as in Fig. 1—which may be easily produced to suit flat ware of any shape or size. Such chucks are faced on the top face to receive the back of the work-piece and are provided with a shaft which is a slide fit in the bore of the main work-spindle. They are, therefore, lightly friction-driven when the machine is in operation. A special device is supplied with each machine to facilitate production of the plaster chucks.

A second type of chuck (Fig. 3) for use with cups and similar articles is also provided. It is fitted with three adjustable metal fingers for the reception of hollow-ware and, as in the case of its plaster flatware counterpart, it is also provided with a shaft which fits the bore of the main work-spindle.

A smaller, bench-type machine (Fig. 4) with a single applicator unit is also available, and although this machine is not intended to perform the range of work of which the larger machine is capable, it has many possibilities including, within its limitations, the lining and banding of some kinds of glassware. In addition, it has been found useful in making trials on small ceramic components requiring thin deposits of gold, platinum, silver and the like.

The writer wishes to acknowledge the assistance given by Mr. M. W. Abberley of F. Malkin and Co. Ltd., Ceramic Engineers, Longton, Stoke-on-Trent, in producing this article.

Depreciation and Maintenance of Pottery Manufacturing Equipment

4.—The Upkeep Factor and Classification of Repairs and Maintenance Charges

by S. HOWARD WITHEY, F.Comm.A., etc.

WHEN pottery manufacturing equipment is properly handled and well looked after it will usually last longer than plant which is subjected to rough usage or neglect, although, of course, intensive operation may increase the danger of obsolescence, and it is always advisable to segregate the charges for repairs, cleaning, overhauling and adjusting instead of showing these items in the same accounts as the charges for depreciation. This will greatly facilitate the compilation of annual and cumulative summaries of the cost of working each unit of equipment and the maintenance of records giving details of all renovation work.

With the object of lowering upkeep costs, first-class organisations have been developed, but in order to keep the charges within limits a systematic control of the different units and groups of equipment is called for. To allow urgent repair work to get out of hand may prove very costly, and a suitable clayworking machinery maintenance system should be instituted by each manufacturer, firm and company. As far as endurance and reliability are concerned, many of the kilns, mix-mullers, grinders, brick-making machines and de-airing pugs are extremely satisfactory and economical, but the real strength of the productive chain is its weakest link and under the conditions which now prevail the cost of renewals and replacements shows a definite tendency to expand, and in the absence of factual information as to the performance, condition and running cost of mechanical equipment, users are compelled to rely largely on estimates, the accuracy of which it is often very difficult to verify.

Manufacturing equipment history sheets are sometimes divided into sections to show the operation and maintenance cost; a classification of the spare parts and accessories fitted from time to time; and the power and fuel consumption, this data being usually compiled in the costing department. The costs may be sub-divided to indicate the nature of all the repairs and overhauls carried out and may be expressed as rates per hour of use. Subsidiary sheets for recording particulars of all renovation and foundation work, time spent, requisitions for components and spare parts, stores issue vouchers, weekly time sheets, details of all gadgets fitted, and departmental reports, etc. provide the information now needed to enable the actual cost of maintenance to be readily ascertained, and these sheets should be certified by the manager and passed on for entry on the abstracts. A simple pattern of equipment history sheet is given on page 512.

The stores ledger should contain accounts grouped under definite headings, the left-hand side being used for the insertion of the quantities and invoiced cost prices of the spare parts, accessories and attachments received, and the right-hand side for entering particulars of all the issues made from stock, and for the value of any returns outwards. Subject to depreciation, to cover which a percentage may be added to the values as recorded on the credit side of specific accounts, the balances will represent the values of the manufacturing requisites under the different headings, and while some firms in the industry rely entirely on the accuracy of such inventory records, it is advisable to verify some of the figures occasionally.

CERAMICS

Description of Equipment ....
Location ....
Accessories ....
Used for ....
Date of Installation .... 19............
Name of Supplier .... No: ....
Cost £ : :

	Cost 1952	*Cost per working hour*	*Cost 1953*	*Cost per working hour*	*Cost 1954*	*Cost per working hour*
Wages:						
Fitters ...						
Operators ...						
Materials ...						
Fuel & Power						
Depreciation ...						
Servicing ...						
Overheads ...						
Provision for Replacement						
Sundries ...						
Spare Parts, etc.						
Wheels ...						
Gear boxes ...						
Motors ...						
Pumps ...						
Filters ...						
Rollers ...						
Mouthpieces						
Racks ...						
Switches ...						
Instruments						
Tools ...						
Miscellaneous						
Total						

In some cases, authorisations for the carrying out of repairs to pottery manufacturing equipment are made out on forms by the manager or supervisor, as and when required, a copy of each form being passed on to the foreman, charge-hand or fitter, to be returned on completion of the job. The specification need not be very elaborate; the essential details to be shown will include a description of the equipment, the number of the job, the dates of starting and finishing, and the names of the fitters and others engaged on the work, and one of the main purposes of these forms is to place on record responsibility for the execution of repairs and renovations.

The forms or sheets which are used for the purpose of ascertaining the cost of labour expended on each unit of equipment usually show the number of hours actually worked during the week, with a separate section for office use and for arriving at the effective rate per hour worked. Details can then be transferred to an equipment repair labour abstract summarising the cost under each heading, week by week, and facilitating the preparation of an annual summary showing the total cost and the nature and frequency of the repairs, etc., carried out during the year. Where the expenditure on repairs and renewals is large, the maintenance will usually be divided into two main classes, one consisting of the daily repairs and adjustments of a relatively trivial nature, and the other the really large maintenance jobs. While the minor repairs may be more numerous and often amount to a very considerable sum, special authorisations are not always needed if the men are able to deal with the jobs right away, and the cost can usually be charged against the standing orders, whereas it is advisable to record the cost of the large maintenance work on the debit side of a repairs and renewals account opened in the nominal or expenses

ledger, the total amount involved being transferred to the final account at the periodical stocktaking or balancing. The cost of betterments is sometimes debited to a depreciation reserve, and, of course, the net cost of new construction, foundation expenses and additions to plant should be capitalised by means of transfers to the specific asset accounts.

Before transferring the balance of the repairs and renewals account to profit and loss, care should be exercised to ensure that no items of a capital nature are included. In all cases when the book value of old or displaced assets has been written off and charged against the manufacturing operations, the full capital cost of the new equipment should be posted to the debit side of the private ledger account and subjected to annual deductions to cover depreciation due to wear and tear, obsolescence and other deteriorating factors. In this connection, the charges for depreciation sometimes include provision for essential tools in addition to a sum of sufficient magnitude to ensure that additional funds will not be required when a section of productive equipment reaches the end of its service.

Some manufacturers prefer to charge each item of work with so much per hour for the use of the equipment, but some machines require a large amount of fuel and service and have to be operated by skilled engineers while other machines require the attention of only lower-grade men, very little power, and no auxiliary service. Variability in tensile strength, electrical resistance, hardness, etc., can sometimes be determined by reference to a basic standard, and each manufacturer should decide whether or not engineers are justified in resorting to methods calculated to eliminate the cause of variation in the quality of repair work.

One of the most effective methods whereby this can be assured is by a statistical method of analysis, and in order to facilitate the taking of preventive rather than curative action the basis or standard may take the form of a graphical record. To ensure efficiency and the greatest practical utility, however, the record should be of inherent simplicity involving simple arithmetic. If the general quality of repair work is allowed to fall, the manufacturing operations would almost certainly be adversely affected, and even when the quality of the work remains within certain predetermined limits it may be advisable to secure a greater degree of productive efficiency, and without some method of statistical control this would be practically impossible. A suitably applied system of priority will ensure that parts and spares needed on straightforward jobs are not retained in the stores for an unreasonable period pending the availability of mating parts, and will do much to avoid deterioration and obsolescence.

One of the five "Siporex" factories in Sweden

Expanding Production of "Siporex" Swedish Building Material

by

JOHN GRINDROD, B.A.(Com.)

OFFERING many properties not found in the more conventional building materials such as wood, bricks and concrete, Siporex, a comparatively new steam-hardened compound of cement, siliceous sand, aluminium powder, other chemicals and substances and water, is now being produced in rapidly increasing quantities not only in Sweden but also in many other countries.

Based on a process initially discovered in 1933 by Ivar Eklund, a civil engineer, and Professor Lennart Forsén, a cement scientist then employed by Sweden's leading cement group Skanska Cement, of Malmö, the production of Siporex has played a considerable part in revolutionising building techniques in Sweden during the last two decades. While experimenting with a type of gas concrete Eklund and Forsén discovered that, if the material was steam-hardened under great pressure, it acquired properties very much superior to those obtained by exposing the same materials to the usual air-hardening process. Not only was the new material almost unshrinkable but its bearing capacity was also greatly improved.

Further experimental work over the next two years brought the development of this new material to a point where its production could be started on a commercial scale and the first factory was put into production at Dalby, Southern Sweden, in 1935. This factory was gradually enlarged to meet steadily growing demand and, in 1940, was followed by a plant at Södertälje, south of Stockholm and another at Gothenburg. In 1945 the largest factory so far built by the Siporex group was erected at Gävle, Central Sweden, while in 1952 a plant at Skelleftehamn in Northern Sweden started production. To date, the total capacity of all five Swedish factories

now in production aggregates 400,000 c. m. (14,124,000 c. ft.) a year. Such is the lag between supply and demand that extensions permitting the production of a further 100,000 c. m. per annum are planned.

To the Södertälje plant, which, standing on a waterway, has access to the sea, cement and siliceous sand, the two main components, are conveyed by ocean transport. Mechanically handled at the quay and then taken by a long conveyor extending over the drying sheds and factory proper, these components are delivered to large storage silos from which they and other components are fed mechanically to the top floor of the factory. The finely ground sand is mixed with the cement, water, aluminium powder and chemicals, which, after preparation, leave the top floor of the factory by pipe-line for the ground floor where the mixture is cast in oiled moulds. Each of the same over-all size the moulds are divided by partitions into the required sizes and patterns for the different pieces of finished material.

The aluminium powder in the mixture sets up a fermentation process which has the effect of creating the cellular structure of the material. When this fermentation process is completed the cast blocks and patterns are left to air-harden for some time before being steam-hardened. The latter process takes place in an "autoclave" in which the steam pressure is gradually increased. The action of the steam causes the sand and cement to amalgamate into the chemical compound calcium monosilicate and it is in this respect that the material differs structurally from ordinary concrete, which represents only a physical combination of the component parts. This gives the Siporex greater structural strength and increased bearing capacity.

Various grades of Siporex are made according to the purposes for which the material is required. This applies to weight per unit of volume, cellular structure and insulating properties. Similarly, the sizes of the finished products vary, e.g., building blocks are made in dimensions 10 in. by 20 in. by 6 in. for southern Sweden while for the northern parts of the country the thickness is increased from 6 in. to 12 in.

Special features of this material, which have made it so popular for constructional purposes, include its ability to be sawn, hewn, nailed and bored, in some respects, more easily than wood. It is lighter than wood and floats better. At the same time it is as weatherproof as stone. Not only is it non-inflammable but it is fire-resistant. Due to its cellular structure of closed pores, its low weight and very slight water absorption, it has good insulating properties against heat and cold.

Siporex blocks can be used for either external or internal walls of buildings up to four or five storeys high, without any bearing concrete structure. In dwellings built higher than this they are usually employed for panel walls and for the whole of the top section. As insulating slabs they are used in thicknesses of from 2 in. to 6 in. and may be applied either as external insulation on concrete walls or interior insulation.

Having the same linear expansion as steel this material can be reinforced in the same way as concrete and this practice is usual with many products such as roofing and floor slabs, beams for window and door openings, etc. The central laboratory of the Siporex group has evolved a treatment for the reinforcing steel to make it rustproof.

At this laboratory continuous control is maintained over the finished products, new developments and application are tested, new machinery designed, while samples of slag, ashes, limestone, etc., intended to be used as raw materials are analysed and tested. These come not only from the Swedish factories but from various parts of the world where Siporex factories are either actually in production or are being planned. The first foreign plant was founded in 1935 at Helsinki, Finland, and the plants at Riga and Reval, now within the Iron Curtain, were started before World War II. In Scandinavia factories were established at Aalborg in Denmark and at Drammen in Norway in 1949. Recent European factories to be opened are at Maisse, near Paris, and at Hamburg, while others are actually being built or are planned for the Continent as well as Latin America, U.S.A., Australia and Africa.

As well as being used for the construction of apartment and small family houses throughout Sweden, it has also been used for large public and industrial buildings such as the Söderjukhuset hospital, the L. M. Ericsson factory at Stockholm and the new Park Avenue Hotel at Gothenburg.

Mechanised Handling of China Clay

MECHANISED handling of bulk cargoes such as china clay has been adopted with some success at Leith where this type of traffic is now completely mechanised.

Pre-war the reverse applied. Virtually every lb. of china clay was manhandled, with as many as forty workers engaged on a typical shift. The rising cost of labour, the hard manual effort involved in manhandling, and the slowness of that system encouraged Mr. John Reid, stevedore, Leith, to consider the possibility of mechanisation.

It was not, however, until 1947 that this plan bore fruit. Then, as a result of initiative on the part of his son, a skilled engineer, the firm put into use the first mechanised system to handle bulk cargoes of china clay from the shed. That system has remained basically unaltered since. At present Mr. Reid is putting his third machine into use, incorporating refinements determined by experience of the earlier units.

In planning mechanisation the firm aimed at reduction of the labour force, more economic handling, faster turn-round of the ship, and elimination of the hard manual effort of manhandling—although not necessarily in that order.

This system has been in use since 1936 on a small scale. The routine and plant are as follows.

The ship is unloaded by grab which can feed up to a maximum of 50 tons per hour, to a quayside hopper of about 30 cwt. capacity. This has a shutter door which allows gravity release to a smaller hopper located at the end of a 30 ft. long flat elevator conveyor. This in turn feeds on to a high level 40 ft. long elevator conveyor, with a possible delivery height of 18 ft. If it should be necessary, as many as five conveyors can be linked to feed the loose dry china clay to the quayside shed where it is stored in bulk against orders from the the paper mills which are the principal users of this type of material. Bulk storage is faster and more convenient and allows the ship to unload quickly and speed is essential from the shipowners point of view. If two grab hoppers are feasible, for instance, the unloading capacity is increased to 100 tons per hour, a tonnage which can be matched by the elevator conveyors.

It might be pointed out here, that, the use of a series of conveyors and elevators of differing sizes allows a great degree of flexibility in location of the clay in the sheds; this could not be done by a fixed conveyor system, quite apart from the need to keep the main floor of the shed open for lorry transport.

Removal of the loose dry clay from the shed has also been fully mechanised. It is here perhaps that the greater credit is due. In unloading, the firm has used available plant; in loading into bags for delivery to the mills, the machinery is entirely a product of the firm's initiative, although Mr. Reid stresses that it is largely built from standard materials.

The bag filler is a mobile unit consisting of a rear worm screw, an elevated hopper, a front weighing system, the whole powered by an 8 h.p. D.C. electric motor. The machine is manhandled into the loose china clay and power switched in. The right and left hand worm gathers the clay to the centre of the machine where an elevating bucket system lifts and discharges it into the top hopper, which holds about 4 cwt. The 2-cwt. bag is held open below the feed mouth from the hopper and is carried on a pivot deadweight weighing system, which records when 2 cwt. of clay has been released by a simple, manual release, shutter.

The filled sacks are then loaded on the 30 ft. long elevator conveyor and delivered to the waiting lorry, normally of the flat platform type.

The first unit was built in 1947 largely as an experiment to determine whether bulk loose china clay could be handled mechanically from the shed.

It proved very conclusively that this was not only feasible but essential from

every point of view. The second bag filler went into use in 1949, and incorporated some improvement, although maintaining the basic design of the original. It has a capacity of 20 tons per hour, which is as fast as bags can be removed from the feeding and weighing mouth.

The latest bag filler, now being completed, also has a capacity of 20 tons per hour. It is thought that this probably represents the maximum speed needed on such work; it is certainly a high speed to maintain continuously and a more practical speed is probably 10 ton per unit in 40 min., instead of the 30 min. indicated. The bag filler is worked by five men and can fill 80 tons a day—when required. Two men feed the worm with clay; one man weighs the empty bags on to the weighing machine; one takes the weighed bag off and ties the mouth, and one barrows the full bag away to the elevator for loading.

All three bag fillers have been built under the personal supervision of Mr. Reid.

A summary of the advantages might be useful.

The working gang at a ship has been cut from perhaps forty to twelve men. Unloading is faster, at the rate of 50 tons per grab per hour, aided by conveyors able to maintain the same speed. Delivery to any point in the shed of bulk loose clay is easy by use of the conveyors and elevators; bag filling has been similarly mechanised completely at the rate of some 20 tons per filler per hour, using relatively cheaply made machines which have paid their cost speedily. Turnround of ships has been immensely improved. All the hard labour or basket carrying previously essential has been eliminated.

Although used here on china clay—in which the firm has established a very strong position by reason of its mechanisation—the method could be used to handle any loose cargo with similar ease.

VIBRATORY FEEDERS

THE latest model vibratory feeder by Podmores (Engineers) Ltd., Pyenest Street, Shelton, Stoke-on-Trent, have already found a wide appeal in the ceramic, engineering, chemical, packaging, mining and quarrying industries. In addition to the normal application for feeding powders, granular and lump material to process plant such as crushers disintegrators, screens, dryers, the machines are used for handling, sorting and feeding small components and pressings in bulk or in a single file, often presenting them in a definite manner.

The feeders are also used for spreading thin layers of material for the coating of abrasive cloths and papers or similar moving bands.

G. W. Bone.—Mr. G. W. Bone, M.A., works director of Davey, Paxman and Co. Ltd., Standard Ironworks, Colchester, has been appointed assistant managing director. He joined Davey, Paxman and Co. Ltd. in July, 1945, as chief experimental engineer, afterwards becoming assistant works manager, which position he held until his appointment in December, 1948, as works director.

The latest model vibratory feeder, by Podmores (Engineers) Ltd.

INDIAN ZIRCON

by

B. L. MAJUMDER, M.Sc., A.M.Inst.F.

THE mineral zircon, $ZrSiO_4$, is the orthosilicate of the metal zirconium and occurs as a fairly uniform sand of average grain size about 0·1 mm. in the monazite-bearing sand extensively found along the coast of Travancore-Cochin. Sillimanite is first separated from these sands by preliminary gravity methods, while zircon is separated as the non-magnetic residue from the high intensity magnetic separator. Rutile is finally separated from zircon by electrostatic separators.

Monazite sand is formed by a cycle of erosion and disintegration of the igneous rocks in the Cardmon and Nilgiris Hills, fragments of these rocks get broken, disintegrated and converted into sands which are washed out into the sea by the rains. According to the geographical features of the extent of the deposits, the mineral-bearing sands are swept back by the peculiar force of the sea currents along the coast. Zircon is one of the first minerals to crystallise out from the cooling rock magma and owing to its high specific gravity of 4·70, this may be completely separated by fluvial sorting. The occurrence of monazite sands in this coastal area was first discovered by a German chemist Mr. C. W. Schemberg in 1909 and was later investigated by the Geological Survey of India.

About 50,000 tons of monazites were separated and exported to various countries of Europe and also to the United States of America between 1910 and 1948 when its export was banned because of its importance as a source of atomic energy. Later, on the recommendation of the Atomic Energy Commission (India), the Indian Rare Earth Limited was formed, as a joint venture of the Government of India and Travancore-Cochin State with 55 per cent. and 45 per cent. shares respectively, in August, 1950, with a view to exploit and process the monazite sands. The factory situated on a 22·5 acre plot in Eloor on the banks of River Periyar went into operation last July and was formally opened by Prime Minister Shri Jawaharlal Nehru on 24th December, 1952. The factory has been designed, to process 1,500 tons of monazite annually.

Zircon, when pure, is a compound of zirconia and silica in the proportions of 67·2 : 32·8 and is white in colour. The commercial product usually contains alumina, titania, phosphorus, iron and hafnium as impurities and is, therefore, usually brown or reddish in colour. The chemical analysis of two Travancore samples are compared below with one pure Australian variety:

	Impure Travancore sample. Ex. P. B. Sillimanite Co.	*Pure Travancore sample. Ex. Thorium Ltd.*	*Pure Australian variety. F. W. Berk & Co.*
SiO_2	29·41	32·45	32·91
ZrO_2 + HfO_2	61·82	66·46	65·89
TiO_2	2·33	0·15	0·24
Al_2O_3, P_2O_5, etc.	5·61	0·99	1·29
Fe_2O_3	0·45	0·29	0·37
Mn_3O_4	0·27	0·08	0·09
MgO	0·10	—	—
Na_2O + K_2O	0·12	—	—

Zircon is one of the few minerals possessing high melting point and available in such abundance as to study its properties as a refractory

material for high temperature installations. The zircon refractories, when made by using temporary bond and incorporating a small proportion of finely divided zircon into the mix and fired to a temperature in the region of 1,500°-1,600° C., have a high refractoriness and refractoriness-under-load, comparatively high thermal conductivity, low thermal expansion and adequate strength leading to good spalling resistance. Besides, when zircon panel was directly subjected to most slagging conditions in a down-jet furnace at B.C.U.R.A., Leatherhead, it showed better resistance to attack by coal ash slag than sillimanite.

Swedish Porcelain

MANY monographies on the ceramic industries have been published. These are our sources of knowledge regarding the work of the great pioneers in china making and the secrets of the different methods. But there are aspects of the history of porcelain making that are not so well represented in this literature. Mostly, it has more to say about great artistic achievements, outstanding exhibition pieces, and costly porcelain made to the order of royalty than about utility ware—although this is far more important because of the much greater volume in which it is produced.

Recently, it is true, a number of books have appeared on old English patterns. But much remains to be told about the history of tableware. A welcome contribution to research in this field is the study now begun by the Nordic Museum in Stockholm. At this museum great attention has always been paid to the important fields which fall between industrial art and handicraft, and thus Swedish historians are in an especially good position to make studies of this kind.

Ceramic tableware is of considerably younger date than is generally realised. In Sweden—land of wood—where the industrial revolution took place later than in Central Europe, the wooden plate remained on common people's tables until well into the 19th century. This is one reason why there are so many objects of historic interest remaining from this primitive period in Sweden.

The main prerequisite for the success of this newly started research work has been the whole-hearted support of the Swedish porcelain industry, headed by the old-established Rörstrand. It is quite natural that Rörstrand should take a special interest in these studies as it is one of the oldest china factories in Europe founded as early as 1727—long before both Sèvres and Wedgwood. With its well-preserved collection of old porcelain, it is possible to single out the different phases of the history of ceramic tableware by studying the production of this factory alone.

From the earliest periods are the Rörstrand faience pieces much sought-after by collectors. These provide interesting evidence of the reciprocal influences of Chinese and European taste. The Chinese pottery was, of course, the unattainable model of the European faience makers.

But soon the English design ideas began to predominate when Rörstrand started manufacturing the more durable flint porcelain early in the 1760's. By the beginning of the 19th century Rörstrand had reached large-scale industrial production in the modern sense of the word, making tableware with romantic Swedish landscape motifs which stood up well in competition with the famous china sets of Davenport, Derby and Wedgwood. A great many of them are, by the way, still manufactured. Then followed the rich variety of 19th century patterns—as abundant at Rörstrand as anywhere. This went on until the famous Stockholm Exhibition of 1930, where a much needed simplication of tableware design took place in line with modern ideas.

Inevitably, the late 19th century patterns which appeal to modern taste are relatively few. This is however a matter which is of no real importance here. If the task of mapping out this jungle of varieties succeeds, it will mean a valuable contribution to the exploration of the richly-facetted development of 19th century taste, maybe dubious in itself, but still highly interesting.

In other connections Rörstrand has previously shown great interest in sponsoring historical research, most recently in archæological subjects. King Gustaf Adolf, who is himself a prominent archæologist, took the initiative in starting excavations in China in the 1920s, where huge treasures of pre-historical stoneware were unearthed. These finds gave a strong stimulus to the development of the Swedish stoneware, whose high standard today is not least due to achievements at Rörstrand.

Insulators from Recent Researches on Porcelain

IN view of greatly increased demands being made on ceramics to fulfil both ordinary insulating and novel requirements, more attention has recently been devoted to their electrical and mechanical qualities, and which is probably most pronounced in the matter of high-tension insulators. Electrical heating, and high frequency and short-wave engineering, represent further branches which have been responded to by comprehensive research and experimental activity. The leading ceramic insulating material for low-frequency, high-tension lines is still claimed to be porcelain, and for which reason continuous methods of production have been developed for porcelain masses of different composition.

While all desirable characteristics cannot be combined in a single material (although a somewhat corresponding system could nevertheless be followed for all varieties) many of them may be produced side by side, thus preventing interference with rapid mass production. Some of these products may possess maximum dielectric strength, high thermic strength, or great mechanical strength, and in conjunction with rapid output, there have been extensive improvements in forming processes, besides the drying and firing treatments. As a consequence, results which formerly were deemed unattainable in the electrical porcelain industry have now been achieved. For example, in the course of regular production, cap-type insulators for 200 kV. lines with a guaranteed disruptive voltage of 145,000 volts, and minimum breaking load of 40,000 lb. are produced. Standardized double-cap insulators in the largest size are guaranteed to have minimum and mean breaking loads of 19,000 and 24,000 lb. and although ceramically of less favourable form, are absolutely proof of puncture. For steel radio towers solid barrel-shaped insulators are manufactured for insulating foundations, and which give way completely only under a load of 70,000 lb. per sq. in. High-tension porcelain condensers for high-frequency telephony in the instance of the 2,200 uuF. capitance, 65,000 volt type, have a puncture exposed surface of some 2,000 sq. in. These are subjected to an alternating current of 140,000 volts and 50 cycles in the preliminary test. As distinct from this, a standard cap-type insulator with a puncture-exposed surface of not more than 39 sq. in., and but slightly less than half this testing voltage, is all that is required. Modern high-tension multiple wall ducts have the entire dielectric stress taken by telescoped porcelain tubes, without use of an oil or composition filling. These are made for operating tensions up to 132,000 volts, and deviate danger from fire, sooting, and explosion. Besides this, they combine absolute weather resistance and invariability of electric properties, with small diameter at the point where the fitting is held.

Porcelain Jackets, Wall Ducts, and Supporting Units.

Porcelain jackets for the terminal bushings of 220/110 kV. open-air transformers of 60,000 kVA. comprise a single piece, and have a height of 8¼ ft. The weight approximates to 2,100 lb. where the petticoat has a diameter of 3¼ ft. and an inside diameter of 2¼ ft.

One product which is notable for its design and dimensions, is the wall duct for 330 volt operating voltage, and which is represented by an outdoor-to-interior duct, 15¾ ft. in length, and 1,650 lb. in weight.

This is composed of four parts with plane-parallel end-faces, which, by a spring seated on the terminal through-bolt, are kept pressed against the flange of the fitting. Even under

the greatest temperature fluctuations which occur in service, the resilient connection of the several components so obtained, ensures absolute tightness of the duct in the horizontal position for which it is designed. Compared with the tension against which it insulates, the foregoing duct is far exceeded by an interior duct of corresponding design constructed for extra-high tension laboratories of large insulating companies, but which is employed for 560 kV. against earth. This has a porcelain weight of 1,840 lb. and is 12¼ ft. in height, and is again a four-part duct, but of sturdier design.

Outdoor and interior supporting insulators which serve for carrying conductors or bus bars, or are used in the construction of isolating switches for the highest voltages, belong to a class of insulators which tax the skill of the manufacturers, because of the stresses for which they are made, or because of their dimensions. The insulators of outdoor rotary isolating switches are liable to suffer a heavy coating of ice on the contacts of the blades during winter, and for which reason, apart from high flash-over strength, high resistance to bending and torsion are also demanded. The presence of this ice exposes the rotating central insulator to torsional stresses, while the insulators carrying the contacts are subjected to bending. Outdoor isolating switches for 220 kV. operating tension, for this reason, are expected to have their 10½ ft. high columns of suitable qualities.

These must stand a breaking load perpendicular to the axis of some 670 lb. and a torsional breaking moment of about 2,100 lb. at 1 ft. radius.

More Stringent Requirements of Insulators.

With the advance of high-frequency engineering, and developments of electrical heating, the demand for insulating materials capable of implementing stringent requirements has become still greater. This relates to great mechanical strength at high temperatures, good insulating power, resistance to temperature variations, and low co-efficient of expansion. The avoidance of combustible insulating materials in switch plants has led to novel designs, such as cascade, cross-hole, and spreader insulating transformers, and all large surfaces of these which are exposed to electrical stresses, are subjected to severe dielectric strength tests. The prescribed wall thicknesses and dimensions of the winding spaces must be maintained with the utmost precision for the sake of measuring accuracy, and because of the close magnetic connections of the windings. Of recent date, efforts have been made to revive the use of stoneware for high-tension insulation.

This material is literally confined to one-piece parts which are not subject to tensile strength, but as its dielectric strength is from 5 to 10 per cent. below that of porcelain, this feature has not to be overlooked.

Steatite is chiefly used in low-voltage engineering with the exception of solid-core and bar insulators, and what has been described about porcelain in a general sense likewise applies to steatite.

Council of Industrial Design. The Board of Trade announce that Mr. W. J. Worboys, B.Sc., D.Phil., has accepted the President's invitation to become chairman of the Council of Industrial Design in succession to Dr. R. S. Edwards, who retires on 31st January, having held the appointment for five years, and having been a member of the Council since its inception in 1944. Mr. Worboys has been a member of the Council since June, 1947. The present chairman of the Scottish Committee of the Council, Mr. R. A. Maclean, has accepted the President's invitation to remain in office for a further two years from 1st February.

A Pocket Size Accounting Machine. The Curta machine will add, subtract, multiply, divide, square, cube and extract square roots, thus making it very useful for invoicing, estimates, interest calculations, currency conversions, and so on. It is fact in operation, easily observed and quite durable in practical use. It packs up into a small, neat cylinder weighing only about half a pound, and is easily carried around. It is of Swiss origin. Further information is available from Mr. M. E. Thomas, 46 Lonsdale Road, Barnes, London, S.W.15.

Gibbons Brothers Vert. Nederland N.V.—The new address of Gibbons Brothers Vert. Nederland N.V. is Henri Jonaslaan, 57 Maastricht. The telephone number remains as Maastricht 4633.

THE COST OF SMOKE

By

W. A. LLOYD DODD

(Newcastle Division, Northern Gas Board)

SINCE the Industrial Revolution the daily pollution of our atmosphere has grown steadily, and it is only in comparatively recent times that really practical steps have been taken to reduce this unpleasant by-product of modern civilisation. In spite of local improvements however, atmospheric pollution, and smoke in particular, remains a grave social and economic problem.

A second fuel problem faces us in this country, even more pressing than the first, for upon its solution depends the maintenance of our standard of living, already considerably reduced. This is the present fuel shortage, exemplified by the recurrent winter crises and likely to be intensified by the expansion of coal consumption at a greater rate than the expansion of output envisaged by the N.C.B.

Not only has the immediate fuel shortage to be tackled, but the conservation of our dwindling reserves of readily obtainable coal, our only raw material of international consequence, is of vital importance.

Smoke Abatement—The Problem

The evils of smoke, and the magnitude of the problem of damage to health, vegetation and buildings amounting to £50,000,000 per year at least, need no elaboration.

The cause is clear. The combustion of bituminous coal in a raw state is responsible for substantially the whole of the smoke produced in this country. There can be little disagreement about that. What of the remedy?

The burning of raw bituminous coal is to be deplored for the two outstanding reasons of the smoke produced and the chemicals destroyed, which must in most cases be otherwise imported. The domestic fire is the worst offender as far as the production of smoke is concerned, not only because of the more destructive nature of the soot due to its higher tar content, but because it is responsible for about half of the total smoke produced in this country while only consuming one quarter of the total coal used.

In the industrial field, gaseous fuel has been steadily superseding solid fuels because of its many advantages, lending itself so obviously to automatic and accurate temperature control and enabling the provision of the requisite furnace atmosphere, apart from the increased cleanliness and ease of operation.

The pottery industry is a typical example, where the gradual replacement of solid fuel by gas is assisting in no small measure to clear away the perpetual smoke cloud which has hung over Stoke-on-Trent. The annual gas consumption of the pottery industry in Stoke-on-Trent is now some 300 million c. ft. as compared with 7½ million in 1932, this increase being due almost entirely to the replacement of coal-fired bottle kilns by gas-fired continuous tunnels.

On Tyneside, too, the industrial gas load has been steadily developing as shown in Table 1, and the replacement of the majority of coal-fired furnaces by gas-fired ones has brought about a big improvement in atmospheric conditions. Boiler-chimneys would appear to be the chief offenders today, and even these are tied to raw coal for economic reasons very much less strongly than they were. Many of the most recent boiler installations in this area, one with an installed

Extracts from a lecture presented to the North Eastern Council of the National Smoke Abatement Society.

TABLE 1.

INDUSTRIAL GAS CONSUMPTION ON TYNESIDE

	Million therms/year industrial and commercial	*% of total gas sold*
1933	6	25
1936	11	37
1939	17	40
1942	25.5	54
1945	23.4	44
1948	29.2	44
1951	37.1	49

steaming capacity of 40,000 lb. hour, are fired by gas, and as gas becomes more readily available this movement will gain momentum.

Supply of Smokeless Fuels

Let us turn now to the availability of smokeless fuels, which term refers normally to the following classes:

1. Anthracites and dry steam coals.
2. Smokeless briquettes.
3. Gas.
4. Gas coke, coke oven coke and low-temperature coke.

Electricity has been omitted because its use for heating can, in the national interest, be justified only in special circumstances.

The reserves of the first class are good and an increase in output would certainly be possible. Pre-war production was about 11,000,000 tons per year, and while it is understood to be considerably less at present, it could probably be raised to say 16,000,000 tons per year over a period of a few years. This, while helpful, would be a comparatively small contribution to our requirements, and such a statement applies even more strongly to any possible increase in the supply of smokeless briquettes.

It is clear, therefore, that for the substantial increase in the supply of smokeless fuels necessary to obviate the combustion of bituminous coal in appliances which produce smoke, we have to rely largely on an expansion of the carbonising industries producing gas and coke.

In order to ensure the highest possible production of goods, at present largely for export and rearmament, and to ensure the increased rates of production per man-hour necessary to keep prices down while labour and capital costs rise, we, in these islands, must make the best possible use of our natural resources, particularly energy.

I stress energy, because in this industrial age, the wealth of any society is so obviously related to the quantity of energy it puts to good account. Thus the available energy per person in the United States is approximately twice that available per person here, while in countries like India and China the figure is only about one tenth of the energy available to an individual in this country.

Therefore, unless we tackle this task of increasing productivity by increasing the availability and efficiency of utilisation of energy in the form of fuel and power immediately and wholeheartedly, our standard of living must continue to fall.

Energy Sources

Disregarding atomic energy, whose future practical value is still somewhat unpredictable, our native energy resources are largely limited to coal.

Hydro-electric and wind-power, while capable of some development, are not considered likely to yield more than a small proportion of our needs. In 1949 water-power generated just over 1,000 million k.w.h. out of a total electricity production of over 49,000 million k.w.h., i.e., 2½ per cent. In 1930, water production produced 3 per cent. of the total.

Production of crude or shale oil in this country is very limited. Compared with 17,500,000 tons of petroleum, crude or refined products, imported in 1949, home-produced oil totalled only 150,000 tons.

It is clear, therefore, that we are almost entirely dependent upon coal for supplies of native energy, and the fact must be faced that the proper and most effective utilisation of our coal resources is absolutely vital.

Utilisation of Coal

In a stimulating paper, entitled "Inefficiency," presented to the Institute of Fuel in March, 1946, Mr. Oliver Lyle attempted to assess the overall efficiency with which coal was

TABLE 2.

	Tonnage (1950)	*Overall efficiency*: %
Gas and Coke	48,800,000	38
Industrial heating	34,300,000	23
Non-industrial and domestic	42,800,000	17
Power	67,400,000	2·2
	193,300,000	

TABLE 3.
SHIPYARD FRAME FURNACE

		Coal-fired	*Gas-fired*
Equivalent weekly coal consumption (tons)		30	23
Annual atmospheric pollution (tons)	Smoke	17	—
	Ash	15	—
	SO_2	53	5

used in this country, and arrived at a figure of 15 per cent.

This figure is somewhat staggering, but there can be little doubt that it is substantially of the right order of magnitude—if anything it is likely to be high rather than low. Perhaps the importance of raising this overall efficiency figure of 15 per cent. is best emphasised by the fact that an improvement of 1 per cent., i.e., to 16 per cent., would mean a saving of some 1,800,000 tons of coal per year—or the work of 3,000 miners.

Scope for Savings

To arrive at his overall efficiency figure, Mr. Lyle estimated the division of our coal consumption between four major methods of use:

1. Conversion to gas and coke;
2. Combustion raw, for industrial heating;
3. Combustion raw, for commercial and domestic heating;
4. Conversion to power;

and attempted to assess the overall efficiency of use in each class.

The efficiency figures obtained are as applicable today as they were in 1944, no recent developments having been of sufficient consequence to effect any appreciable alteration, but some slight alterations are required to bring the tonnage distribution figures up to date, since the comparative figure for the total home consumption of coal in 1950 was 193·3 million, an increase of 16·6 million tons over the 1944 figure.

A careful survey of 1950 coal consumptions, industry by industry, has led to an amended version of Mr. Lyle's figures (Table 2).

Power, which here includes factory steam engines and the railways, as well as electricity generating stations, has its own particular applications for the driving of machinery and provision of lighting, and it is not proposed to discuss it on this occasion, when the primary interest is in the other three items which cover the use of coal for heating purposes.

An Example

A coal-fired frame heating furnace in a shipyard was double sided, and output requirements necessitated both sides being in operation, the coal consumption averaging 30 tons per week.

This furnace was converted to gas firing, and the use of one side of the furnace only was found to be necessary to meet the same production, the gas consumption averaging just over 1,800 therms per week—requiring the carbonisation of only 23 tons of coal per week. It must be remembered in addition, however, that the production of this gas is accompanied by the production of 12 tons of coke together with tar, benzol and sulphate of ammonia, which are available for other purposes.

Assuming the coal-fired furnace to

have been typical of general industry, annual atmospheric pollution will have been reduced from something like: burning coal, 17 tons smoke; 5 tons ash, and 53 tons SO_2 to, burning gas, 5 tons of SO_2 with no emmission of smoke and ash (see Table 3) or, even if one includes the carbonisation process itself and the combustion elsewhere of the 12 tons coke produced at the same time, 20 tons of SO_2 with only very small quantities of smoke and ash.

In addition to these two national gains, of reduced coal consumption and of reduced atmospheric pollution, the shipyard has gained to the extent of a considerable reduction in weekly fuel and labour costs for the furnace.

Thus, in the particular, and in general, it is clear that a considerable reduction in the national coal consumption can be achieved by the replacement of bituminous coal burned directly in domestic and industrial appliances by gas and coke.

Industry has been turning steadily to gas for the past twenty years, because of its many advantages in the accurate control of temperature and furnace atmosphere, and the figures for the expansion of the use of gas on Tyneside for industrial and commercial purposes has already been given in Table 1.

Developments in the field of gas and coke utilisation are occurring all the time, and the heating processes which cannot be effectively carried out on an economic basis by either gas or coke are few indeed.

Summary

The current evils of too much smoke and too little fuel are known only too well.

A major contribution to the solution of both these problems can be obtained by the gradual replacement of all bituminous coal at present burned raw for industrial, commercial and domestic heating purposes, by gas and coke.

There would be the additional advantage of the recovery of the valuable by-products at present destroyed.

Such a project would be little more than a speeding up of existing tendencies, but would require the doubling of our present carbonisation capacity.

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